APPENDIX A: TECHNICAL NOTES

Development of the risk-adjustment model involved selection of an outcome measure, selection of risk factors, estimation and testing the model, and calculation of the outcome measures for CAP admissions (see "Report for the California Hospital Outcomes Program, Community-Acquired Pneumonia, 1996: Model Development and Validation" at the following web site: www.oshpd.ca.gov/HQAD/Outcomes/Studies/CAP/index.htm, click on Model Development and Validation). The original model was developed using data collected in 1996. For this report, risk factor coefficients were recalculated using the discharge data collected in 2002-2004.

DATA SOURCES

The primary data source for this report was the Patient Discharge Data (PDD) collected by OSHPD. The PDD is an administrative abstract of the medical record and is required for each discharge of a patient who has been admitted to any California non-federal acute care hospital. Patients admitted to a non-acute level of care (e.g., skilled nursing, rehabilitation) were excluded. For this report, CAP patients were selected from the 2002, 2003, and 2004 PDD files, with a subsequent match to admissions reported in the 2001 file.

Each patient discharge abstract includes a principal diagnosis and principal procedure, plus as many as 24 other diagnoses and 20 other procedures. For each diagnosis there is a flag to indicate whether the diagnosis was a condition present at admission (CPAA). Each record also includes the patient's Social Security Number, demographic characteristics (e.g., age, gender, race, and ethnicity), and information about the hospitalization episode (e.g., dates of admission and discharge, presence of a DNR order, source of admission, destination of the discharge, and expected source of payment).

In order to identify deaths that occurred after discharge, the PDD analysis files were matched to the Death Master Files for 2002, 2003, and 2004, using Social Security Number as the identifier common to both datasets. The Death Master File includes all death certificate information recorded in California, by year. It is maintained by the California Department of Health Services.

SELECTION OF HOSPITALS

All acute care hospitals reporting discharge information to OSHPD were eligible for inclusion.[1]

If a hospital consolidated with another facility during the report period and stopped reporting discharges from the original hospital, all discharges reported after

[1] This involved selecting all CAP records with a "level of care" code indicating "General Acute Care."

consolidation were attributed to the "new" hospital named in the consolidation. Any discharges prior to consolidation retained their original hospital identification. If a hospital changed location and then reported discharges using a different facility identification, it was reported separately under the same hospital name with a different street address.

SELECTION OF PATIENTS

Inclusion and exclusion criteria were developed after careful review of the medical literature and extensive discussions with an expert panel. The panel included a pulmonologist, a nurse researcher, a pulmonary care nurse, a pharmacist, and a health information management professional.

Inclusion Criteria

Unduplicated CAP patients were selected from the PDD for the years 2002-2004. For patients with two or more CAP admissions during a given year, only the first qualifying admission was considered.[1] This definition fulfills the general requirement of case independence for the statistical analysis model used in this report. The first qualifying admission is referred to as the "index admission."

Cases selected for this report were required to meet all four inclusion criteria, as follows:

1. **A principal diagnosis of community-acquired pneumonia or a specified pneumonia-related principal diagnosis with a secondary diagnosis of community-acquired pneumonia.**

The principal diagnosis is "the condition chiefly responsible…for hospital admission." Secondary diagnoses are defined as "conditions that coexist at the time of admission, develop subsequently during the hospital stay, affect the treatment received, or affect the length of stay."[1] If CAP was the principal diagnosis, the patient was selected. For patients with CAP-related principal diagnoses (e.g., cough), a secondary diagnosis of CAP was required for selection. This approach was used in prior research on community-acquired pneumonia.[2]

Table A.1 shows the ICD-9-CM (International Classification of Diseases - 9th Revision - Clinical Modification) diagnoses that were used to define community-acquired pneumonia.[3]

2. **Age at admission of 18 years or older.**

This study included adults only. The clinical spectrum of pneumonia for children is

[1] Office of Statewide Health Planning and Development, March 2001, 1999 Patient Discharge Data File Documentation.
[2] Iezzoni LI, Shwartz M, Ash A, Mackieman YD. Using severity measures to predict the likelihood of death for pneumonia inpatients.
J Gen Intern Med. 1996; 11:23-31.
[3] Fine M, Singer DE, Hanusa B, et al. Validation of a Pneumonia Prognostic Index Using the MedisGroups Comparative Hospital Database. The American Journal of Medicine. 1993; 94:153-159.

significantly different. In order to include children it would be necessary to develop a second risk-adjustment model and validation instrument.

3. **Source of admission is "Home."**

Because this study is focused on cases of pneumonia that were acquired outside of institutions (i.e., in the community), only patients whose source of admission was "Home" were included in the report. Patients admitted from "Residential Care Facilities," "Long Term Care" and "Other Inpatient Hospital Care," or from "Prison/Jail" may be exposed to organisms with different patterns of antibiotic resistance than individuals living in non-institutional settings. They can cause pneumonia that has a different, often a more severe, clinical course than pathogens typically associated with CAP. Patients transferred from a long-term care facility are also more likely to have "Do Not Resuscitate" (DNR) orders. These patients have a higher risk of serious underlying medical conditions that may not be fully measured in a risk adjustment system using administrative data. Admissions from "Ambulatory Surgery" and "Other" sources were also not included because there was no information available about where these patients normally resided.

4. **Date of discharge between January 1, 2001 and December 31, 2004 plus date of admission between November 1, 2001 and December 1, 2004.**

Patients admitted before November 1, 2001 (two months prior to first study year) were excluded because the analysis was designed to capture CAP patients primarily treated during the years of study. Patients admitted between December 2 and December 31 of the last study year (2004) were excluded since death certificates were not available at the time of analysis to determine 30-day mortality for these late admissions.

Table A.1: CAP Diagnoses Included in the Analysis

ICD-9-CM Code	Principal Diagnosis	Principal CAP Codes	Non-CAP Principal Diagnosis Codes*
480.0	Pneumonia due to adenovirus	X	
480.1	Pneumonia due to respiratory syncytial virus	X	
480.2	Pneumonia due to parainfluenza virus	X	
480.8	Pneumonia due to other virus not elsewhere classified	X	
480.9	Viral pneumonia, unspecified	X	
481	Pneumococcal Pneumonia (*Streptococcus pneumoniae*)	X	
482.0	Pneumonia due to *klebsiella* pneumoniae	X	
482.1	Pneumonia due to *pseudomonas*	X	
482.2	Pneumonia due to *hemophilus influenza*	X	
482.30	Pneumonia due to *streptococcus,* unspecified	X	
482.31	Pneumonia due to *streptococcus*, Group A	X	
482.32	Pneumonia due to *streptococcus*, Group B	X	
482.39	Other s*treptococcus* species	X	
482.4	Pneumonia due to s*taphylococcus* species	X	
482.81	Pneumonia due to other specified bacteria - Anaerobes	X	
482.82	Pneumonia due to *escherichia coli* (E. Coli)	X	
482.83	Other gram negative bacteria	X	

482.84	Legionnaires' disease	X		
482.89	Other specified disease	X		
482.9	Bacterial pneumonia unspecified	X		
483.0	Pneumonia due to other specified organism-*mycoplasma*	X		
483.1	Pneumonia due to other specified organism - *chlamydia*	X		
483.8	Pneumonia due to other specified organism	X		
485	Bronchopneumonia, organism unspecified	X		
486	Pneumonia, organism unspecified	X		
487.0	Influenza with pneumonia	X		
510.0	Empyema with fistula			X
510.9	Empyema without fistula			X
511.0	Pleurisy without mention of effusion or current tuberculosis			X
511.1	Pleurisy with effusion, with bacterial cause other than tuberculosis			X
512.0	Spontaneous tension pneumothorax			X
512.1	Iatrogenic pneumothorax			X
512.8	Other spontaneous pneumothorax			X
513.0	Abscess of lung			X
518.0	Pulmonary Collapse			X
518.81	Respiratory failure			X
518.82	Other pulmonary insufficiency, not elsewhere classified			X
785.5x	Shock without mention of trauma - shock unspecified			X
786.00	Dyspnea and respiratory abnormalities-respiratory abnormality, unspecified			X
786.09	Other dyspnea and respiratory abnormalities			X
786.2	Cough			X
786.3	Hemoptysis			X
786.4	Abnormal sputum			X
038.xx	Septicemia			X

* To be used as an inclusion criterion, a non-CAP principal diagnosis must occur with a secondary diagnosis of CAP.

Exclusion Criteria

Several exclusion criteria, such as a recent history of pneumonia acquired in the hospital, were defined in order to eliminate patients that may not truly represent CAP. Cases with any of the following characteristics were excluded.

1. **One or more prior acute inpatient hospital admissions within 10 days preceding the index CAP admission.**

A CAP admission was excluded from the study if it was preceded by a hospital discharge for any reason within 10 days prior to the CAP index admission. This exclusion is important because recent hospitalizations put a patient at risk for hospital-acquired pneumonia.

2. **Any diagnosis code on the index hospital record indicating trauma.**

Trauma patients were excluded because it was highly likely that an accident victim would have acquired pneumonia in the hospital.

3. **Discharges with diagnosis codes indicating that the patient had undergone organ transplant, had human immunodeficiency virus (HIV) or AIDS, had cystic fibrosis, tuberculosis, post-operative pneumonia, certain unusual pathogens as the cause of the pneumonia, or other diagnoses identified by clinical consultants to OSHPD.**

Individuals with AIDS or HIV infection are susceptible to a wider variety of pneumonia-causing pathogens than are non-immune suppressed patients and their clinical course may be different from other pneumonia cases. Similarly, organ transplant patients receive medications to suppress the immune system, making them susceptible to pathogens that do not normally cause pneumonia acquired in the community. Patients with cystic fibrosis are not able to clear bacteria effectively from their lungs and are as a result more susceptible to pneumonia. The frequency with which they develop pneumonia and receive associated courses of antibiotics increases their risk of infection by antibiotic-resistant bacteria. This increases their risk of acquiring infection with an antibiotic resistant pathogen, which makes their treatment more difficult. Patients with tuberculosis were excluded because this type of pneumonia requires specific antibiotics and has a very different clinical course than patients with CAP. Patients with postoperative pneumonia are clinically classified as having hospital-acquired pneumonia. Some unusual pneumonias (e.g., anthrax) were also excluded because these organisms are treated with specific antibiotics and have a different clinical course.

Table A.2 lists the pneumonia diagnoses that were excluded because their etiologies and treatment regimes are clinically distinct from most cases of CAP.

4. **Other exclusions.**

Patients were also excluded if they had: (a) a missing, invalid, or uncertain Social Security Number (because their data records could not be linked); (b) missing or unknown gender data; (c) an error in the date of death (date was missing or preceded the date of admission); (d) an out-of-state ZIP code (because they might or might not have a death certificate filed in California).

Table A.2: Pneumonia Diagnoses Excluded from Analysis

ICD-9-CM Code	ICD-9-CM Description
Fungal Pneumonia	
112.4	Candida species
114.0	Primary Coccidioimycosis
115.05, 115.15, 115.95	Histoplasmosis Pneumonia
484.6	Aspergillosis Pneumonia
484.7	Pneumonia from Other Systemic Mycoses
Other Miscellaneous Pneumonias	
136.3	Pneumocystis carinii
484.1	Pneumonia from Cytomegalovirus
484.3	Pneumonia from Whooping Cough
484.5	Pneumonia from Anthrax
484.8	Pneumonia in other Infectious Disease
73.0	Ornithosis with Pneumonia
39.1	Primary Actinomycosis
55.1	Post-Measles Pneumonia
003.22	Salmonella Pneumonia
130.4	Pneumonia Due to Toxoplasmosis
21.2	Pulmonary Tularemia
52.1	Varicella Pneumonitis

*To be used as an inclusion criterion, a non-CAP principal diagnosis must occur with a secondary diagnosis of CAP.

LINKING HOSPITALIZATION AND DEATH FILES

Linking the index admission (first CAP admission for the patient) with subsequent hospital discharge records, as well as the death certificate file, provided the basis for detecting deaths that occurred within 30 days after the index admission. Linkage with prior hospitalizations provided the basis for identifying cases that were acquired in a healthcare setting and for information about clinical risk factors and co-morbidities that might have been absent from the index record. Co-morbidities, such as asthma and liver disease, may not always be coded on the index CAP discharge record even though they were present.

The Record Linkage Process

The record linkage process was performed in order to identify records from different data files for the same individual and to create an analysis file with a single record ("line") for each case. This was accomplished through the following steps:

1. Index admissions were identified that met the selection criteria.

2. Eligible index admission records were linked to the California death certificate records. Each death certificate was linked to all applicable records in the patient discharge data files, but each patient discharge data record was linked to either one death certificate or no death certificate. A deterministic linkage was performed using the patients' social security number as the primary linkage key. A detailed description of the algorithm is in the technical guide of OSHPD's report on heart attacks for 1996-1998. (This is available at www.oshpd.ca.gov/HQAD/Outcomes/Studies/HeartAttacks/index.htm)

3. Additional discharge records for each patient that occurred within six months prior to the index admission were located and linked with the appropriate index records. The patients' social security numbers served as the primary linkage key.

MEASUREMENT OF 30-DAY MORTALITY

Although "improved health" and "improved ability to do everyday tasks" are desirable outcome measures, mortality was chosen as the outcome measure for this report because it is important, definitive, and readily available. Furthermore, death is an appropriate measure of quality of care because prevention of some of the deaths is possible through medical interventions. Therapies that have been shown to be useful in prevention of death for CAP patients include appropriate use of antibiotics[1] and performance of sputum cultures at admission.[2]

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[1] Meehan TP, Fine MJ, Krumholz HM, et al., "Quality of Care, Process, and Outcomes in Elderly Patients with Pneumonia." *JAMA*. 1997; 278(23): 2080-4.

[2] Haas J, et. Al., "Report for the California Hospital Outcomes Project: Community-acquired Pneumonia, 1996," Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page 12-9.

The thirty-day mortality rate is used because it is a more robust and complete measure than the in-hospital mortality rate. It is not biased by variation among facilities in how decisions are made about the timing of patient discharge; the in-hospital mortality rate will be undercounted in hospitals that discharge ill patients early.

Among the CAP patients admitted during 2002-2004, there were a total of 25,027 deaths within 30 days of the index admission. Of these, 15,444 (61.7%) died during the index hospitalization. The remaining 9,583 deaths (38.3%) occurred after discharge.

Deaths were determined using the linked hospital discharge abstracts and vital statistics records (death certificates). The hospital discharge abstracts include only deaths occurring in the hospital. A death certificate is generated whenever a California resident dies, regardless of where death occurs. In a previous validation study of this linkage, OSHPD found that 98.8% of the in-hospital deaths were also reported in the death certificate files.

RISK FACTORS IN THE MODEL

Risk factors were defined as characteristics or conditions that existed at the time of admission and possibly influenced the patient outcome. Hospitals in which a high percentage of the patients had these risk factors (that is, hospitals with a high risk case mix) would be likely to have higher mortality rates, apart from the quality of care provided.

Four types of risk factors were considered:

- Demographic characteristics, such as gender and age;
- Hospitalization characteristics, such as number of prior admissions;
- Chronic clinical risk factors, such as asthma, liver disease, and lung cancer;
- Acute clinical risk factors, such as respiratory failure, coagulation deficit, and acute cerebrovascular accident, that may or may not be present at admission to a hospital.

All clinical risk factors were based on diagnoses and procedures listed on discharge abstracts and coded using the International Classification of Diseases-9th Revision-Clinical Modification (ICD-9-CM).

Demographic and Hospitalization Characteristics

Table A.3 details the demographic characteristics of the CAP patients selected for this report. Only age and gender are included in the CAP risk-adjustment model because they were the only demographic variables found to be sufficiently predictive of 30-day mortality.

Table A.3: Demographic Characteristics of CAP Patients (after exclusions)

Characteristic		2002		2003		2004 (Jan.-Nov.)	
		Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Total Patients		72,701		72,353		58,593	
Gender							
	Male	34,489	47.4	34,287	47.4	28,043	47.9
	Female	38,212	52.6	38,066	52.6	30,550	52.1
Race/Ethnicity							
	Caucasian	48,941	67.3	47,635	65.8	38,617	65.9
	African American	6,041	8.3	5,983	8.3	4,702	8.0
	Latino	10,639	14.6	11,422	15.8	9,151	15.6
	Native American	213	0.3	192	0.3	147	0.3
	Asian/Pacific Islander	5,216	7.2	5,386	7.4	4,559	7.8
	Other	1,242	1.7	1,315	1.8	1,069	1.8
	Missing/Unknown	409	0.6	420	0.6	348	0.6
Age							
	Mean	70.0		69.5		69.6	
	Standard Deviation	16.8		17.1		16.9	

Table A.4 provides the characteristics of the hospitalization events experienced by the CAP patients. Of these, the only characteristic that was selected by the validation study for inclusion in the model was the number of prior discharges within the previous six months.

Table A.4: Hospitalization Characteristics of CAP Patients (after exclusions)

Characteristic		2002		2003		2004 (Jan.-Nov.)	
		Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Total Patients		72,701		72,353		58,593	
Admission Type							
	Scheduled	1,754	2.4	1,756	2.4	1,306	2.2
	Unscheduled	70,923	97.6	70,475	97.4	57,248	97.7
	Missing/unknown	24	0.0	120	0.2	39	0.1
Payment Source							
	Missing	9	0.0	5	0.0	13	0.0
	Medicare	48,156	66.2	47,681	65.9	38,676	66.0
	Medi-Cal	8,139	11.2	8,286	11.5	6,612	11.3
	Private Coverage	12,790	17.6	12,550	17.4	10,047	17.2
	Worker Compensation	66	0.1	54	0.1	61	0.1
	County Indigent Programs	1,179	1.6	1,222	1.7	963	1.6

	Other Govt	284	0.4	330	0.5	283	0.5
	Other Indigent	182	0.3	196	0.3	173	0.3
	Self Pay	1,564	2.2	1,800	2.5	1,516	2.6
	Other Payer	332	0.5	229	0.3	249	0.4
Number of Prior Discharges							
Mean		0.6		0.5		0.5	
Standard Deviation		1.1		1.0		1.0	

Clinical Risk Factors for Mortality

Identification of clinical risk factors for the CAP model was accomplished in two ways. First, as part of the 1996 CAP development and validation study, clinically important factors were identified through a review of recent medical literature plus input from a clinical advisory panel. Second, additional risk factors were identified by selecting factors in the 1996 data that had significant correlations with 30-day mortality.

Factors were selected for consideration if their prevalence was greater than 1% among CAP patients and if the validation study found them to be reliably coded in the PDD. They were eliminated if the correlation with mortality (in univariate analyses) was not statistically significant, if they lacked clinical justification, or if they had counter-intuitive associations with mortality. In addition, physiologically related risk factors showing similar associations with mortality were grouped to form new variables in cases where they had low individual frequencies (less than 1% of all cases).

Risk factors were retained if they were significantly associated with 30-day mortality in the full, multivariate model. The clinical risk factors selected for use in the model are shown in Table A.5.

Table A.5: Prevalence of Clinical Risk Factors

Risk Factor	Prevalence (Percent of Patients with the Risk Factor)
CHF	30.10
Asthma	11.95
Do not resuscitate order	11.51
Respiratory failure	10.21
Chronic renal failure	7.12
Solid cancer, non-lung	6.89
Septicemia	6.10
Late effects of CVA	4.99
Hematologic cancers	4.75
Chronic liver disease	4.21
Staph. Pneumonia	3.28
Coagulopathy	3.26
Lung cancer	2.63
Parkinson's disease	2.24
Gram negative species	2.18
Acute CVA	1.23

DNR as a Risk Factor

In the 1996 validation study, having a DNR order proved to be highly predictive of 30-day mortality. The odds ratio for DNR was the strongest single predictor or mortality. Its odds ratio (OR = 17.0) was higher than the OR for the 23 other risk factors used in the model. Inclusion in an expanded model, along with five other clinical risk factors taken directly from hospital charts, substantially raised discrimination for the PDD-based risk-adjustment models, raising the C-statistic from 0.80 to 0.91.

In the analysis of the 2002-2004 data, reported here, DNR status was also found to be an important predictor of 30-day mortality, second only to respiratory failure in the risk-adjustment model (see Tables A.8 and A.9). Model discrimination increased when DNR was added, raising the C-statistic from 0.797 to 0.824. The observed mortality rates, statewide, were more than four times higher for CAP patients with DNR orders (38.7%) than for those without (9.1%).

Reporting of DNR

The 24-hour DNR reporting rate was 11.5% for the 2002-2004 cases (see Table A.6), compared with 10.7% in the previous report (1999-2001 cases). These percentages are substantially lower than those found in a 1996 review of medical charts by OSHPD (27.0%), and closer to the 14.9% reported by Marrie et al.[1] It appears that hospitals may have underreported DNR orders during the periods of these two CAP reports. A systematic validation study from a sample survey of hospital charts was launched in 2006 to assess the completeness and validity of DNR reporting.

Table A.6: Distribution of Hospitals by DNR Admission Percent

Percent of Admissions with DNR order	Number of Hospitals	Percent of Hospitals
No DNR Cases	14	3.59
0.1 - 3.0	38	9.74
3.1 - 5.0	42	10.77
5.1 - 8.0	70	17.95
8.1 - 10.0	43	11.03
10.1 - 15.0	83	21.28
15.1 - 20.0	47	12.05
20.1 - 25.0	21	5.38
25.1 - 50.0	23	5.90
50.1 – 100.0	9	2.31
All Hospitals = 11.51% (N=390)		

[1] See: Marrie TJ, Fine MJ, Kapoor WN, Coley CM, Singer DE, and Obrosky DS, “Community-acquired Pneumonia and Do Not Resuscitate Orders”, Journal of the American Geriatric Society, 2002, Feb; 50(2): 290-9. Marrie, et al reported a rate of 14.9% for a sample of 1,339 community-acquired pneumonia admissions to hospitals in the United States and Canada.

Construct Validity and the Use of Two Models

In this report, DNR status is used as an indirect indicator of illness severity at time of admission. It is valuable because the dataset lacks any other direct measures of clinical severity, such as laboratory values. However, since DNR is by definition a request from the patient to withhold emergency and/or long-term, life-saving treatments, presence of a DNR order may have an effect on decisions about treatment which we cannot measure with the available data.

If DNR status indicates both underlying illness severity at the time of admission and variation in the treatment received, then its use as a risk factor creates a methodological dilemma. On the one hand, its omission might cause the model to under-adjust for patient severity of illness. On the other hand, adjustment for DNR orders could mask the treatment effects that the model is intended to detect. OSHPD's solution to this dilemma was to rate hospitals using *both* models according to the following rules:

- If the risk-adjusted mortality of a hospital was significantly *lower* than the state average using *both* models, then that hospital's mortality outcome was rated as significantly "better" than expected.
- If the risk-adjusted mortality rates of a hospital were significantly *highe*r than the state average using *both* models, then the hospital's mortality outcome was rated as significantly *"worse" than* expected.
- If a hospital's risk-adjusted mortality was rated *as expected* on *either* model, then that hospital's mortality rate was rated *as expected*.

The effect of using both models to rate hospitals is summarized in Table A.7. In this table, the marginal distributions for the separate models are very similar, with 248 hospitals rated "as expected" for both models and an additional 61 rated "as expected" in only one model. The total number rated "as expected" for the 2002-2004 report is 309. Twenty-five hospitals were rated "better" by both models and twenty-eight were rated "worse" by both. Twenty-eight had too few cases to be appropriately analyzed statistically.

Adding DNR to the model improved the rating for some facilities and had the opposite effect for about an equal number of others. In no case did it change a hospital's rating from "better" to "worse" or vice versa. Specifically, for 279 hospitals rated "as expected" without DNR, adding DNR to the model changed the rating to "better" for 18 and to "worse" for 13. On the other hand, for 83 hospitals rated as outliers (41 "better" and 42 "worse"), adding DNR changed their ratings to "as expected" for about one third.

Table A.7: Comparison of Hospital Ratings, With/Without DNR as a Risk Factor

		Hospital Rating With DNR As Risk Factor			
		"Better" (+)	As Expected	"Worse" (−)	TOTAL
Hospital Rating Without DNR as Risk Factor	"Better" (+)	25	16	0	41
	As Expected	18	248	13	279
	"Worse" (−)	0	14	28	42
	TOTAL	43	278	41	362

Note: This table excludes 28 hospitals that were not rated because of small sample sizes (see Table 3).

Using the model that does not include DNR, the "better" hospitals had an average risk-adjusted mortality rate of 7.9% (range: 4.8 – 9.8%), compared to an average of 17.0% (range: 14.7 – 22.1%) for "worse" hospitals. After adding DNR to the model, the risk-adjusted mortality rates increased to 8.1% (range: 5.2 – 9.7%) for "better" hospitals and 17.2% (range: 14.3 – 23.7%) for "worse" hospitals. That is, after adjusting for DNR, the average risk-adjusted mortality rate for "worse" hospitals was more than twice as high as the rate for "better" hospitals.

TIMING OF CLINICAL RISK FACTORS

Before 1996, California hospital discharge abstracts did not include any information on the timing of diagnoses. Therefore, any acute condition could be either a co-morbidity (e.g., present at admission) or a complication of care (e.g., present only after admission). After 1996, a new "condition present at admission" (CPAA) flag was reported in the abstracted data in conjunction with each recorded diagnosis. This field was used to differentiate co-morbidities from complications.

In addition, pre-existing co-morbidities were identified by linking the index CAP record to any other hospitalization reported during the prior six months. The prior abstracts provided additional information about the presence and timing of clinical risk factors. If a risk factor was noted on a prior discharge abstract then it clearly preceded the index CAP admission and thus did not require reference to a CPAA indicator.

THE RISK-ADJUSTMENT MODELS

Tables A.8 and A.9 show parameter estimates, odds ratios (ORs), and confidence intervals (CIs) for the risk factors in each of the models, with and without use of DNR as a predictor. All of the risk factors were found to be statistically significant predictors of mortality except infection due to gram negative species (Table A.8).

The strongest predictors of death in both models were the following: having a diagnosis of respiratory failure (OR = 5.19), followed by diagnoses of lung cancer, septicemia, non-lung solid cancer, and coagulopathy. The remaining predictors had odds ratios that were significant but less than 2.0. Asthma had a protective effect (OR = 0.5): possibly patients with both asthma and CAP are treated more aggressively and have a lower threshold for hospital admission. In the model that includes DNR, having a DNR order in place is one of the strongest predictors of mortality (OR = 4.2), second only to respiratory failure.

Table A.8: Parameters for Model without DNR as a Risk Factor

Risk Factor	Parameter Estimate	P Value	Odds Ratio	Lower 95% CI For Odds Ratio	Upper 95% CI For Odds Ratio
Intercept	-6.0674	<.0001			
Age	0.0442	<.0001	1.045	1.044	1.046
Male	0.093	<.0001	1.097	1.064	1.132
Septicemia	1.1106	<.0001	3.036	2.895	3.184
Respiratory failure	1.6468	<.0001	5.19	4.997	5.392
Staph. Pneumonia	0.4448	<.0001	1.56	1.457	1.671
Chronic liver disease	0.6259	<.0001	1.87	1.744	2.005
Lung cancer	1.2146	<.0001	3.369	3.14	3.614
Solid cancer, non-lung	0.9322	<.0001	2.54	2.422	2.664
Hematologic cancers	0.5907	<.0001	1.805	1.703	1.913
Chronic renal failure	0.3489	<.0001	1.418	1.347	1.492
Late effects of CVA	0.2298	<.0001	1.258	1.186	1.335
Coagulopathy	0.7142	<.0001	2.043	1.912	2.182
Gram negative species	0.0381	0.4222	1.039	0.947	1.14
CHF	0.1794	<.0001	1.196	1.158	1.236
Parkinson's disease	0.2524	<.0001	1.287	1.182	1.401
Acute CVA	0.1677	0.0036	1.183	1.056	1.324
Asthma	-0.6696	<.0001	0.512	0.48	0.546
Number of prior discharges	0.1408	<.0001	1.151	1.137	1.166

Table A.9: Parameters for Model with DNR as a Risk Factor

Risk Factor	Parameter Estimate	P Value	Odds Ratio	Lower 95% CI For Odds Ratio	Upper 95% CI For Odds Ratio
Intercept	-5.6516	<.0001			
Age	0.0347	<.0001	1.035	1.034	1.037
Male	0.1428	<.0001	1.153	1.118	1.19
Septicemia	1.038	<.0001	2.824	2.69	2.964
Respiratory failure	1.6457	<.0001	5.185	4.988	5.389
Staph. Pneumonia	0.4638	<.0001	1.59	1.484	1.704
Chronic liver disease	0.607	<.0001	1.835	1.71	1.969
Lung cancer	1.1229	<.0001	3.074	2.861	3.302
Solid cancer, non-lung	0.8678	<.0001	2.382	2.269	2.5
Hematologic cancers	0.5918	<.0001	1.807	1.704	1.917
Chronic renal failure	0.3853	<.0001	1.47	1.396	1.548
Late effects of CVA	0.1577	<.0001	1.171	1.103	1.243
Coagulopathy	0.7324	<.0001	2.08	1.945	2.224
Gram negative species	0.0444	0.3519	1.045	0.952	1.148
CHF	0.1864	<.0001	1.205	1.166	1.245
Parkinson's disease	0.162	0.0002	1.176	1.079	1.282
Acute CVA	0.1927	0.001	1.212	1.081	1.36
Asthma	-0.6266	<.0001	0.534	0.501	0.57
Number of prior discharges	0.1295	<.0001	1.138	1.124	1.153
Do not resuscitate status	1.4333	<.0001	4.193	4.044	4.346

Internal Validity of Risk-Adjustment Models

For this report, internal validity is defined as how well the model controls for differences in patient characteristics that would otherwise confound outcome comparisons across hospitals. Not adequately controlling for such differences may generate biased and misleading estimates of risk-adjusted mortality rates. Internal validity was assessed in three ways: face validity, discrimination, and goodness of fit (i.e., calibration).

Face Validity

Members of the CAP clinical advisory panel and additional consultants reviewed the 1996 CAP risk-adjustment model, including the selection of covariates and model parameters, to ensure that it was both clinically appropriate and consistent with previous research in the field. This panel judged the model to be an adequate representation of risk factors associated with 30-day mortality for CAP. The panel was not reconvened to review the 2002-2004 report because there was no change in the risk-model being applied to the PDD data.

Discrimination

A perfectly discriminating model would be able to correctly predict each death. That is, it could assign every patient an expected probability of either zero (survival) or one (death). We do not expect statistical models to be capable of perfect discrimination, but they should be accurate more often than they are wrong (better that 50-50 guessing).

A commonly used measure of discrimination is the C-statistic. This measure is based on comparisons of all possible pairs of cases involving one decedent and one survivor.[1] In the study reported here, the C-statistic can be interpreted as the proportion of the times that any CAP patient who died had a higher probability of death than a survivor. The C-statistic may show a value between 0.00 and 1.00. A value higher than 0.50 indicates an overall pattern of discrimination in an expected direction, where patients who died had higher expected probabilities of death than survivors. A value of exactly 0.50 would indicate random variation, that is, lack of discrimination. Values less than 0.50 would indicate discrimination in an unexpected direction, where patient outcomes were opposite to the predicted outcomes. There is no widely accepted cutoff for the C-statistic that defines a model as "adequate."

As shown in Table A.10, the current models' C-statistics were approximately 0.80 and 0.82, for models without and with DNR respectively. These are identical to the results reported by the 1996 CAP development validation study, and are comparable to other models used by OSHPD in previous studies.

Table A.10: Discrimination and Goodness-of-Fit Tests for Re-Estimated CAP Risk-Adjusted 30-day Mortality Models

	Without DNR as a Risk Factor	With DNR as a Risk Factor
Number of Cases	203647	203647
Number of Deaths	25027	25027
30-day Mortality Rate	12.29%	12.29 %
Discrimination C-statistic	0.797	0.824
Goodness of Fit Statistic (χ^2)		
Overdispersion Estimate	1.2498	1.1921
P-value	<.0001	<.0001

Goodness of Fit

Goodness of fit (calibration) is the extent to which observed outcomes correspond to predicted outcomes across the full range of outcome values. In a well-calibrated model, there is a close correspondence between the observed and predicted outcomes across the full range of patient characteristics. A lack of such correspondence (called over-dispersion), can occur for several reasons. There may be a false assumption of a linear

[1] The C-statistic is equivalent to the area under a receiver operating characteristic curve, which represents a plot of sensitivity versus 1-specificity at various cutoff values for the predicted probability. See: Hanley JA, McNeil BJ. *The meaning and use of the area under a receiver operating characteristic (ROC) curve*. Radiology 1982; 143:29-36.

relationship between the logit transformation of the dependent variable (i.e., mortality) and its explanatory variables. Alternatively, the model might lack important interaction terms among explanatory variables or might predict extreme values (i.e., outliers) poorly.

The 1996 CAP validation study reported an over-dispersion estimate of 1.18 (statistically significant at $p<0.001$), suggesting that there was an over-dispersion problem in the model. However, there is close correspondence of observed and predicted values across the full range of model outcomes. Thus, the researchers who developed the model hypothesized that the lack of model fit was due to the effect of having a very large numbers of patients in the study data, with possible omission of higher order interactions. To test the latter, they multiplied the estimated variances by the over-dispersion estimate. This increased the widths of confidence intervals by only 9 percent and did not produce any qualitative changes in report findings, indicating that there was no need to model interactions or non-linearity.[1] The present report obtained similar over-dispersion estimates of 1.25 and 1.19 ($p<.0001$ for both) for the non-DNR and DNR models respectively.

EXCLUSION FROM FULL RISK-ADJUSTMENT

The guidelines that professional coders follow when they abstract medical records may be ambiguous and subject to multiple interpretations. Hospitals also face financial incentives that affect how diagnoses are coded, particularly for Medicare beneficiaries. Consequently, the prevalence of various CAP risk factors across hospitals can vary due to coding practices rather than differences in case mix.

There was no evidence of unusual coding practices that would seriously distort comparisons of risk-adjusted mortality across hospitals. However, we examined the CPAA ("condition present at admission") indicators and found a possible pattern of coding error for some hospitals. Generally, a secondary discharge diagnosis for a patient can be present at the time of admission or it can appear after admission, during the episode of hospitalization. It is unlikely that *all* secondary diagnoses for *all* of a hospital's CAP patients would be present at admission or that *none* of them would be present at admission, especially in hospitals with relatively large numbers of CAP patients. Among the 15 clinical risk factors used in the model, three (respiratory failure, coagulation deficit and acute cerebrovascular accident) are regarded as acute. That is, they could either be present either at the time of admission or could develop afterwards. The remaining 12 clinical variables are considered chronic and may be assumed to be present at admission. Consequently, coding errors on CPAA are relevant primarily for these three acute clinical risk factors.

We excluded the three acute clinical risk factors from a hospital's risk adjustment in any of the semi-annual reporting periods for that hospital when its CPAA coding met both of the following criteria:

1. There was a sufficient number of CAP discharges to reliably assess CPAA coding

[1] Haas J, et. Al., "Report for the California Hospital Outcomes Project: Community-acquired Pneumonia, 1996, Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page 9-2.

(i.e., 80 or more[1]) at a given hospital in a six-month reporting period;

2. CPAA coding for secondary diagnoses showed either none or all as present at admission.

For the periods with suspected CPAA coding errors we used only the 12 chronic clinical risk factors and demographic variables in the risk-adjustment for the hospital, omitting adjustment for the three acute clinical risk factors.

Additionally, the Patient Data Section of OSHPD's Health Information Division checked the logical consistency of the data within each six-month reporting period and noted that some hospitals exhibited unacceptable CPAA indicator coding. We also excluded these hospitals from full risk adjustment during each six-month period with problematic data. Table A.11 lists hospitals and reporting periods that received partial risk adjustment.

Table A.11: Hospitals Excluded from Full Risk-Adjustment

	Six Months Reporting Period					
Hospital Name	**2002-1**	**2002-2**	**2003-1**	**2003-2**	**2004-1**	**2004-2**
Barstow Community Hospital	E		XE		E	
Coastal Communities Hospital		E		E	E	
College Hospital-Costa Mesa	X					
Community Hospital of Long Beach					E	
Desert Valley Hospital	XE	XE				
Emanuel Medical Center	E	E			E	E
Encino Tarzana Rgnl MC-Encino		E	E			
Fallbrook Hospital District					E	
Good Samaritan Hospital-Bakersfield		E	XE			
Granada Hills Community Hospital				X		
Hanford Community Hospital		E				
Lancaster Community Hospital	E					
Los Angeles Co Harbor-UCLA Medical Center	E				E	E
Los Angeles Community Hospital			E		E	
Los Angeles Metropolitan Med Center	X	X	E			
Madera Community Hospital			XE			
Mayers Memorial Hospital	X	X	X	X		
Mission Community Hospital-Panorama	E	E	E			
Mountains Community Hospital				X		
Ojai Valley Community Hospital	E					
Pacific Hospital of Long Beach		E				
Palomar Medical Center	E	E	E	E	E	
Paradise Valley Hospital						E

[1] Haas J, et. al., "Report for the California Hospital Outcomes Project: Community-acquired Pneumonia, 1996," Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page "5-3."

Parkview Community Hospital		E	E	E		E
Pioneers Memorial Hospital		E				
Pomerado Hospital	E	E		E		
Ridgecrest Regional Hospital	E		E	E	E	
Santa Marta Hospital			E	XE	X	
Santa Ynez Valley Cottage Hospital	X					
Selma District Hospital	E	E	E	E		
Simi Valley Hospital & Health Svcs						E
South Coast Med Ctr		E		E		
St. Luke Med Ctr	X					
St. Mary's Med Ctr-San Francisco	E					
St. Vincent Med Ctr	E					
Sutter Davis Hospital	E	E	E			
Temple Community Hospital			E			
Tulare District Hospital				E	E	E
Vaca Valley Hospital	E					

Key: X = Inaccuracies noted by the Patient Data Section of OSHPD's Health Information Division; E = Possible inaccuracies detected by empirical analysis according to the criteria described above.

Finally, we assessed unusual patterns in the prevalence of "key" risk factors: congestive heart failure, respiratory failure, and septicemia. Table A.12 shows the statewide prevalence and the prevalence range across hospitals, for each of the key factors. A cut-off for under- or over-coding of the key factors based on the distribution of the data was evaluated on a hospital-by-hospital basis. The hospital-specific analyses did not indicate that any hospital should be removed from risk adjustment. This is consistent with the CAP validation study, which found adequate accuracy of coding on key risk factors.

Table A.12: Statewide Prevalence and Range of Key Risk Factors

Key Risk Factor	Statewide Prevalence	Range Across Hospitals
CHF	30.09 %	0.0 % – 71.42 %
Respiratory Failure	10.20 %	0.0 % – 45.45 %
Septicemia	6.10 %	0.0 % – 15.62 %

Note: Range includes only hospitals with more than 30 CAP admissions.

CALCULATION OF HOSPITAL OUTCOME MEASURES

Application of the risk-adjustment model to the 2002-2004 PDD data for CAP patients produced risk-adjusted mortality rates for each California hospital shown in Chart 1. Additional detailed hospital statistics were provided to hospitals showing their own risk-adjusted mortality rates for each separate year.

Observed Deaths: Number and Rate

The number of observed deaths at a hospital is simply the total number of CAP patient deaths that occurred within 30 days after the index admission. These deaths could have

occurred during the index hospitalization, during a subsequent hospitalization, or while the patient was not hospitalized. The observed mortality rate at a hospital equals the number of observed deaths, divided by the total number of CAP patients at that hospital. This quantity was multiplied by 100 to express the result as a percentage.

Expected Deaths: Number and Rate

The number of expected deaths at a hospital is obtained from the risk-adjustment model, in four steps, as shown in the following example:

- First, for each patient, each risk factor is multiplied by its model coefficient, as shown in Tables A.8 and A.9. For example, using the model without DNR (Table A.8) we would calculate the probability of death for a 67 year old man admitted with respiratory failure by multiplying: age 67 x .0442, male gender (1) x .0930, and respiratory failure (1) x 1.6468.
- Second, we add these together with the intercept (-6.0674) and obtain the sum of -1.367 (z) for the patient.
- Third, we apply the formula p=1/(1+e-z). For this patient we find that the estimated probability of death is .203.
- Fourth, after obtaining the estimated probability of death for each patient in this way, we sum these results across all the patients in the hospital. This sum is the expected number of deaths for the hospital.[1]

The expected mortality rate at a hospital equals the number of expected deaths, divided by the total number of CAP patients at that hospital. If a hospital's expected mortality rate is higher than the statewide rate, patients at that hospital were sicker (were more likely to have the risk factors) than the statewide average. If a hospital's expected rate is lower than the statewide, then patients at that hospital were healthier than the statewide average.

Risk-Adjusted Mortality Rate Calculation

The risk-adjusted (or indirectly standardized) mortality rate at a hospital equals the statewide rate, multiplied by the ratio of the number of observed deaths to the number of expected deaths at that hospital,[2]

$$I_i = s\left(\frac{\sum_{j=1}^{n_i} o_j}{\sum_{j=1}^{n_i} \hat{p}_j}\right) = s\frac{O_i}{\pi_i}$$

where Ii is the indirectly standardized outcome rate for the jth hospital, s is the statewide outcome rate, oj is the observed value of the adverse outcome (0 or 1) for the jth patient, and $\hat{p}_j$ is the estimated (expected) probability of the adverse outcome for the jth patient. The latter two variables are summed over all patients at the jth hospital.

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[1] All analyses in this report were conducted using SAS Statistical Software, Version 9.1, SAS Institute Inc., Cary N.C. Estimated probabilities of death within 30 days of admission were calculated using PROC LOGISTC.

[2] The methodology used to calculate these limits is described on page 93 of Chapter Eleven in the *Technical Appendix for the 1991-1993 Heart Attack Outcomes report* (www.oshpd.ca.gov/HQAD/Outcomes/Studies/HeartAttacks/index.htm).

The ratio of the number of observed deaths to the number of expected deaths at a hospital provides a quick assessment of that hospital's performance. For a hospital with fewer observed than expected deaths, this ratio is less than one; for a hospital with more observed than expected deaths, this ratio is greater than one. This risk-adjusted mortality rate provides a basis for comparing the performance of different hospitals because each hospital's rate is adjusted to reflect what its mortality rate would be if its patients were about as ill as the statewide average.

Confidence Limits for Risk-Adjusted Mortality Rates

Confidence limits are constructed from the standard deviation and the number of observed deaths at each hospital.[2] There is a 98% chance that the true risk-adjusted mortality rate falls within 98% confidence limits, assuming that the model is valid.

The size of the confidence interval indicates the reliability of a hospital's risk-adjusted mortality rate. In general, when the upper and lower confidence limits are far apart, the estimated risk-adjusted mortality rate is less reliable. This occurs if there is wide variation among the hospital's patients and/or a small number of patients are reported from that hospital.

RESULTS: RISK-ADJUSTED CAP MORTALITY RATES

Risk-adjusted hospital outcomes based on both models are summarized in Chart 1. Hospitals are alphabetically listed within each county. Hospitals rated significantly "better" or significantly "worse" than expected using *both* models are highlighted with gray.

The row labeled "D" indicates the risk-adjusted 30-day mortality obtained from the model that *included DNR* status as a risk factor. The row not so labeled indicates the risk-adjusted 30-day mortality obtained from the model that *did not include DNR* status as a risk factor, using the same set of patients. If you cannot find a particular hospital, it is possible that the hospital did not treat community-acquired pneumonia patients during 2002-2004 or that it had a different name at that time.

Comparing Observed and Expected Mortality

For both risk-adjustment models, two separate one-tailed analyses of statistical significance were performed to determine whether hospitals showed mortality rates that were significantly "better" (lower) or significantly "worse" (higher) than expected. Differences (according to statistical theory) that would be expected by chance less than one time in a hundred were considered significant. Such differences are represented by the term "$p<0.01$." This is a relatively strict level of statistical significance that helps to discriminate hospitals that were "better" or "worse" than expected from those that performed "as expected" when compared to the state average.

[1] Williams RL. Measuring the effectiveness of perinatal medical care. Medical Care 1979; 17:95-110.

The exact probability of the number of observed deaths (or a more extreme number) occurring by chance, given the number of expected deaths at a hospital, was used to identify outlier hospitals. This approach differs from the more widely used normal approximation in that it relies on fewer distributional assumptions and gives better estimates for hospitals with relatively few expected deaths.[1]

If the number of observed deaths exceeded the number of expected deaths, an upper probability (p) value was computed. If the number of observed deaths was less than or equal to the number of expected deaths, a lower probability (p) value was computed. The classification of a hospital's CAP mortality rate as "significantly better than expected," "significantly worse than expected," or "not significantly different than expected" was based on a p-value threshold of 0.01. Hospitals classified as significantly "better" than expected had fewer deaths than expected and a p-value less than 0.01. Hospitals classified as significantly "worse" than expected had more deaths than expected and a p-value less than 0.01. This is equivalent to a two-tailed significance test based on a 98% confidence interval.

Hospitals showing mortality rates significantly "better" than expected ($p<0.01$) are represented by a plus sign (+). Hospitals showing mortality rates significantly "worse" than expected ($p<0.01$) are represented by a minus sign (–). Hospitals that were not significantly different than expected (i.e., that were in a middle range because they were neither significantly better nor significantly worse) are not assigned a symbol.

Symbols representing results:

(+) Significantly "better" than expected ($p<0.01$)
(–) Significantly "worse" than expected ($p<0.01$)
Absence of a symbol indicates performance "as expected"

Comparing Risk-Adjusted Hospital Rates with the Statewide Mortality Rate

Chart 1 compares the risk-adjusted mortality rates of hospitals to the statewide rate using both models. The black solid circle (●) on a row's horizontal bar marks the hospital's risk-adjusted mortality rate. The number on the bar is a hospital's risk-adjusted 30-day mortality rate. A vertical hyphenated line extending from the top to the bottom of the chart represents the overall, statewide 30-day mortality rate for CAP admissions.

Two separate one-tailed significance tests, each at the one percent confidence level, were combined to produce the 98% confidence intervals around a risk-adjusted rate. The bars represent the 98% confidence bounds surrounding an adjusted mortality rate. If each hospital's population of CAP patients in this report is viewed as a separate random sample from the state's population of hospital admissions, then the interval

[1] Luft HS, Brown BW Jr. Calculating the probability of rare events: Why settle for an approximation? Health Services Research 1993; 28:419-439.

may be interpreted to mean that there is a 98% probability that any given hospital's true risk-adjusted mortality rate falls somewhere along that bar. Therefore, if the bar crosses the state average, the hospital's 30-day mortality rate is considered “not significantly different” from the state average. If the bar does not cross the state average, then the difference between the hospital’s 30-day mortality rate and the state’s rate is considered statistically significant. In a few instances, the bar representing a hospital’s confidence interval was too wide to completely fit onto Chart 1. When this happened, a portion of the interval on one side of a mortality rate (●) was truncated and represented by an arrow (← or →) at the end of the bar. In general, the more cases a hospital admits, the narrower its confidence interval. According to statistical theory, larger samples yield more reliable results.

There were 28 hospitals that admitted fewer than 30 patients during the three-year period of this report. These small numbers often resulted in extremely wide confidence intervals that could not be meaningfully interpreted. These hospitals were not rated as significantly higher or significantly lower than the statewide 30-day mortality rate and are not shown in Chart 1. They are listed in Table 3 in the main section of the report.

LIMITATIONS OF THE DATA AND MODEL

Quality of care is one reason a hospital’s mortality rate may be unusually high or low. However, there are additional factors that may contribute to the results.

Unmeasured Risk

The hospital administrative records that were used for this report included ICD-9-CM coded diagnoses and procedures. However, these records did not include clinical findings (such as body temperature, X-ray results, or serum sodium levels) or social/economic factors (such as access to preventive medical services and local prevalence of respiratory disease). If these additional factors had been available, it is possible that a model could have been developed to more fully account for differences in the severity of patient risk across the hospitals.

Variations in Reporting (Data Quality)

Variations or errors in reporting practices may affect a hospital’s risk-adjusted outcomes. Hospitals that failed to report important risk factors or had other data quality problems could have received too little “credit” for their patient risk in the risk-adjustment process. Also, their results could be based on patients that should have been excluded. For example, if there were patients admitted from facilities such as board and care homes who were erroneously reported to OSHPD as “admissions from home” they would have met the CAP definition and been included in this report; if they had been coded correctly in the submitted data they would have been excluded.

The CAP validation study based on 1996 admissions, however, found that differences in hospital reporting practices explained little of the variation across hospitals in risk-adjusted mortality.

Process of Care

Hospitals designated as having “better” (or “worse”) outcomes may provide a better (or worse) quality of care than those not so designated. The process of care in hospitals was not measured in this study, so the specific practices that may account for variations among hospital performances are not reported here. However, the validation study for community-acquired pneumonia suggested a possible difference between hospitals with low risk-adjusted mortality and those with high risk-adjusted mortality. For patients without a Do Not Resuscitate order, the best performing hospitals were significantly more likely to perform sputum cultures at admission. The worst performing hospitals were less likely to perform sputum cultures at admission. The sputum culture could be a marker for procedures that the validation study was unable to measure or could be an important procedure in its own right.

Limited Type of Patient Care

This report provides information on only the care of patients with community-acquired pneumonia. It does not address the quality of care for any other condition and should not be used as a general measure of hospital quality.

Second, it addresses only the outcomes of patients hospitalized for pneumonia. Thresholds for admission may differ among hospitals. Some CAP patients may be treated only in outpatient settings. Others may die at home without ever presenting for medical treatment.

Third, this report focuses on a single measure of outcome: 30-day mortality. It does not address other outcomes such as a patient’s quality of life after discharge or likelihood of having subsequent hospital readmissions. Other organizations that monitor different aspects of healthcare quality are listed in Appendix C with contact information.